Clinical Investigations

COMPARATIVE ANALYSIS OF THE RESULTS OBTAINED AFTER UNICONDYLAR KNEE ARTHROPLASTY AND HIGH TIBIAL OSTEOTOMY IN ISOLATED GONARTHROSIS

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ABSTRACT

The aim of this study was to analyse the results of the surgery and compare the outcomes of unicompartmental knee arthroplasty and high tibial osteotomy performed in isolated gonarthrosis.

Patients and Methods: Between 2007 and 2011, 65 patients were implanted a partial knee endo-prosthesis in the Clinic of Orthopedics and Traumatology. Men were 23 (35.4%) and women were 42 (64.6%). High tibial osteotomy was performed to manage the unicompartamental gonarthrosis in 92 patients (47 men and 45 women) for 13 years between 1975 and 1987. These two modalities were used only in cases in which one of the knee joint compartments was affected. Clinical, para-clinical, functional tests and radiographic examination were conducted of the affected knee joint. Results: The results of the study were assessed by the rating system proposed by the Knee Society and modiﬁed by John Insall. At four-year follow-up study the outcomes of the partial prosthesis were assessed as excellent in 85.13%, good - in 13.11% and satisfactory in 1.77% of patients. After high tibial osteotomy the results were considered very good in 54.18% of patients, good - in 32.29%, satisfactory - in 6.25%, and poor - in 7.8%. Conclusions: Partial knee arthroplasty is a resurfacing procedure, while high tibial osteotomy is used only to slow the overall degenerative process with gradual progressive exacerbation of osteoarthritis with age. The results after prosthetic treatment had a better dynamics than that in high tibial osteotomy.

Key words: isolated gonarthrosis, high tibial osteotomy, unicompartmental knee replacement, varus/valgus deformity

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INTRODUCTION
The degenerative joint disease is a serious medical condition with extensively studied diagnostic process, histological findings and radiologic changes. The degenerative changes follow an incessantly progressive course after their onset. When conservative therapeutic modalities run out of any options to efficiently manage the condition, patients begin to seek surgical treatment. The belated referral of patients to surgery is very often the reason why the optimal time for surgical invasion is frequently missed out. Today all new methods and advanced technologies introduced into medicine have made surgery the most preferred option on the management of arthritis affected joints. It has a proven efficiency also in the treatment of osteoarthritis (OA) of the knee joints.2 At present, but more frequently in the past, the isolated form of this disorder is treated with high tibial osteotomy using variety of techniques (varus, valgus, wedge-shaped, ovoid, dome osteotomy, etc) with subsequent fixation of the fragments (cast, external fixators, retaining plaques, locking plaques).3-5 Unicondylar knee replacement, which is considered in the relevant literature as an alternative to high tibial osteotomy, is now gaining greater popularity.6-11

OBJECTIVE
We present in this study the results we had in the management of the disorder and analyse comparatively two surgical techniques used in treatment of isolated gonarthrosis - the unicondylar knee arthroplasty (UKA) and the high tibial osteotomy (HTO).

PATIENTS AND METHODS
In the study we focus on the surgical treatment of knee joint osteoarthritis using UKA and HTO and then compare the results. This condition, at the onset, usually affects only one compartment of the knee joint. Surgery is then especially apposite to improve the knee condition and by reducing the complaints of patients enable them to lead productive daily life. UKA and HTO are the two surgical modalities that can be applied in such cases.12

Between 2007 and 2011, 65 patients underwent surgery to have partial knee endoprosthesis implanted in the Department of Orthopedics and Traumatology at St. Georgi University Hospital in Plovdiv. Of these, 23 (35.4%) were men, ranging in age from 54 to 72 years. The female patients were 42 (64.6%) in the age range of 52 to 84 years. Left knee prostheses were implanted to 13 men (56.52%) and 25 women (59.52%) and right knee prosthetic joints - to 10 male patients (43.47%) and 17 females (40.47%). One female patient aged 57 years received both prosthetic knee joints. This operating technique was used in a total of 66 knee joints.

High tibial osteotomy was used to treat unicompartmental gonarthrosis for 13 years, from 1975 to 1987 in the Department. This surgical modality was used in 92 patients, of which 84 (91.30%) had varus deformity, and 8 (7.30%) - valgus deformity. Male patients were 47 (51.08%) and female patients - 45 (48.91%). Bilateral high tibial osteotomy was performed on 11 patients. Thus, this operational technique was applied to 103 knee joints. All operated patients were then followed up regularly with clinical and radiologic monitoring of all results.

We did the following studies preoperatively:

A. Clinical tests
B. Paraclinical tests
C. Functional studies for all patients

For patients that underwent UKA we used Insall’s modified KSS for assessment of the knee joint – prior to and after surgery. In 1993 Dr John Insall modified the original rating system for knee assessment. The system he modified combines a relatively objective Knee Score based on the clinical parameters and a Functional Score based on how the patient perceives that the knee functions with specific activities.13

For the patients that underwent the two surgeries we compared the following parameters: knee joint pain assessment, knee range-of-motion, and preoperative and postoperative patient’s gait.

D. Radiologic tests
For patients receiving UKA we used basically the Kellgren & Lawrence system and the Ahlbäck classification to determine the extent of osteoarthritis of the knee.14 The patients were graded according to Ahlbäck’s classification – 42 (64.6%) patients had grade 1 knee OA, 15 patients (23.1%) had grade 2 OA, and 8 patients (12.3%) – grade 3 OA. According to the Kellgren and Lawrence system, 25 (38.5%) patients had OA grade 1, 36 (55.4%) patients had grade 2 OA, and 4 (6.2%) patients had grade 3 of knee OA.

The arthritic process in other compartments can be postoperatively assessed using the radiographs. The findings on the radiographs can also help us detect any loosening of the prosthesis components. The following features can assist in the assessment:
1. Migration of a prosthetic component.
2. Fissure in the cemented fixation of the prosthesis
3. Evidence of an uninterrupted fissure line more
E. Preoperative planning - each radiography was assessed in two projections (frontal and lateral) under load, and also the axial projection of the patella. We use a variety of templates to determine preoperatively the size of prosthetic components. In UKA no overcorrection is recommended for the available preoperative deformity because it leads to arthritic progression in the opposing compartment. Our goal is to restore the anatomic axis of the limb in neutral position and when this is impossible - to reduce to a certain extent the varus/valgus deformity near the anatomic axis of the lower limb.

We used a minimally invasive surgical approach to reach the affected compartment of the knee joint. Then we follow the sequence of surgical steps.10,16

The postoperative protocol was an individual-adjusted kinesitherapeutic program including early mobilization of joints adjacent to the operated one. Patients were made to stand up on the second postoperative day and are trained in walking, climbing and descending stairs with aids until their discharge from the hospital.

The results were analysed statistically using the analysis of variance and correlation analysis with the help of SPSS 19.0.

RESULTS

For a period of four years in the Department of Orthopedics and Traumatology 66 knee joints were operated on for UKA. Targeted follow up was performed at months 1 and 6, then at 1, 2, 3 and 4 years after surgery. During that period, at months 1 and 6 and one year postoperatively, 66 joints (100%) were examined, in the 2nd year - 61 joints, in the third year - 53 and during the fourth - 43 joints. The pain was localized in the medial section of the knee joint in 64 of the cases (96.97%) and in the lateral section in 2 cases (3.03%). Sixty-two knees received a prosthesis of the medial compartment because of the medial OA, and 2 – a lateral compartment prosthesis due to wearing out of this compartment. Aseptic necrosis of the medial femoral condyle was diagnosed in two knee joints which underwent UKA. For assessment of preoperative and postoperative results indicators from Insall’s modified scoring system (Knee Science Score) were used. The analysis of the obtained results was based on these indicators.

UKA CLINICAL RESULTS IN THE TREATMENT OF UNICOMPARTMENTAL GONARThROSIS

A. KNEE JOINT PAIN

1. Pain at rest – it gradually abated, preoperatively and then postoperatively, during the follow-up periods, until patients complained no more of pain. There was still slight pain at rest in two knee joints four years after beginning of the study, which can be accounted for by the very advanced degenerative process in these joints prior to surgery. Correlation analysis was used to compare the pain intensity in the first month of study to 4 years postoperatively. The results were as follows: no pain in 85.07% versus 36.36% previously; slight pain in 11.83% versus 43.94% previously; moderate pain in 6.20% versus 15.15% before UKA. Th severe pain disappeared completely after surgery during the follow up.

2. Pain in motion; quite a great percentage of patients felt no pain in the joint in walking after knee prosthetic surgery. They began to move without feeling the discomfort they had before they received UKA. As most of the knee compartment was previously affected by osteoarthritis, the majority of patients reported very slight reduction of pain after the operation. Analysis of the results showed the following dynamics: no pain in motion in 52.68% for the four year follow-up versus 9.09% before surgery (in r (Pearson) = 0.81; p < 0.001), slight pain in 42.82% versus 71.21% preoperatively (r = 0.63; p < 0.001), and moderate pain in 5.41% versus 16.67% before UKA (r = 0.56; p = 0.043). The pain in motion gradually decreased over the period of follow-up, the therapeutic process being enhanced by physiotherapy and sanatorium and spa treatment of patients.

3. Pain in climbing stairs: the number of patients feeling pain in the knee joint while climbing stairs before surgery tended to decrease in the postoperative period. At the end of the four years of study there was intermittent pain in ten knee joints, which responded very well to analgesic agents when needed. Patients’ complaint did not affect the functional state of the prosthetic knee or their daily activity. Analysis of the results for the follow-up period showed the following: reduction of pain syndrome until it gradually disappeared - no pain in climbing stairs in 50.99% (p < 0.001) versus pain of different intensity before UKA; mild pain...
in 43.94% versus 72.23% before surgery \( (r = 0.62; p < 0.001) \); moderate pain in 5.75% versus 18.18% before surgical intervention.

**B. RANGE OF MOTION IN THE KNEE JOINT**

Range of motion in the knee joint - maximum extension in prosthetic joints was preserved during the follow-up due to the fact that the operation was aimed to reach 3-to-7-degree inclination during resection of the tibial slope, which further helps to improve extension in the operated knee. In inclinations greater than 7 degrees, and especially in anterior cruciate ligament injury, anterior instability of the knee joint increased. An important requirement to perform UKA is the range of flexion to be no less than 90 degrees. The knee joint flexion in two patients was 90 degrees but they were still included in our study. After arthroplasty the flexion improved by 15 degrees, reaching 115 degrees. The degenerative process, which had previously affected both knee joints, was significantly advanced.

**C. ASSESSMENT OF GAIT BEFORE AND AFTER UKA**

Assessment of gait before and after UKA: before the surgery we assessed the gait of 65 patients (100%): the gait was normal in 35 (53.84%), 23 (35.38%) had a limping gait, while seven of the patients (10.76%) used walking aids. After UKA, at four-year follow-up, 62 (95.38%) patients had a normal gait, 23 (35.38%) had a limping gait, while seven of the patients (10.76%) used walking aids. After UKA, at four-year follow-up, 62 (95.38%) patients had a normal gait, 23 (35.38%) had a limping gait, while seven of the patients (10.76%) used walking aids.

**CLINICAL RESULTS OF HTO USED IN THE TREATMENT OF UNICOMPARTMENTAL GONARThROSIS**

1. Knee joint pain dynamics before and after HTO. The operated knee joints were 103 (100%), all with different kind of pain. Constant pain was reported in 48 (46.60%) joints, and pain in motion – in 55 (53.40%) joints. Ninety-six joints (100%) were examined over the four year follow-up. In 78 joints (81.25%) there was no pain felt, persistent pain was felt in 6 (6.29%) patients, and 12 (12.50%) complained of pain upon movement.

2. Dynamics of range of motion before and after HTO - preoperative study of range of motion (flexion and extension) of the affected knee joints showed no major abnormalities. Prior to HTO 103 joints were examined (100%): of these 60 (58.26%) had an extension angle of 180 degrees, 35 joints (33.98%) reached an extension angle of 170 degrees, and 8 (7.76%) – 160 degrees. Ninety-six joints (100%) were assessed in the follow-up of four years. In 86 of them (89.58%), the extension angle postoperatively was 180 degrees, and in 10 joints (10.42%) it was 170 degrees.

A total of 103 joints were examined prior to HTO: of these, 52 (50.49%) had a flexion angle of 120 degrees, 3 (2.91%) joints reached a flexion angle of 110 degrees; in 11 joints (10.66%) the flexion was 100 degrees, in 35 joints (33.98%) – 90 degrees; no joint had a flexion angle of 80 degrees; in one joint it was 70 degrees, in another joint the flexion was 60 degrees (0.97%). The postoperative results for the study period were as follows: 72 (75.0%) joints had a flexion of 120 degrees, 10 (10.42%) joints had a flexion of 110 degrees; in 4 (4.16%) the flexion was 100 degrees; in 7 (7.29%) – 90 degrees; in 2 joints (2.09%) the flexion was 80 degrees and in 1 joint (1.04%) the flexion angle was 40 degrees postoperatively.

4. Changes in gait before and after HTO – the gait of 92 patients (100%) was assessed preoperatively: 42 (45.65%) had a normal gate, 45 (49.92%) patients had claudication; walking aids were used by 5 (5.43%) patients. During the study period (1-4 years) 81 patients (92.05%) had a normal gait, 2 patients (2.27%) had claudication, walking aid was used by 5 patients (5.68%).

**DISCUSSION**

Unicondylar knee arthroplasty is associated with minimal bone resection and bone loss, sparing dissection of soft tissue, less blood loss, preservation of patient’s own tissues and ligaments. This surgical procedure does not affect the knee joint proprioception. Patients still perceive the prosthetic knee as their own after surgery. Before the introduction of UKA, lateral closing wedge high tibial osteotomy (LCWHTO) was the gold standard in the treatment of isolated knee osteoarthritis for years. This technique, however, is associated with several drawbacks. In performing LCWHTO osteotomy of the fibula is required, which threatens direct harm to n. peroneus, passing close to its upper third. LCWHTO leads to damage of the proximal tibial-peroneal joint, and there is a significant loss of bone mass. This is in turn associated with increased blood loss. During the intervention itself, control of tibial slope is difficult. If for some reason it becomes necessary to switch from HTO to total knee arthroplasty, the difficulties become considerably greater. Methods to retain the achieved correction are plaster immobilization, external fixative or metal osteosynthesis. Plaster immobilization until bone callus has formed in the area of osteotomy is uncomfortable for patients. It often loosens, which results in loss of the achieved
correction. Postoperatively, it is sometimes necessary to open the plaster, due to swelling of the lower extremity. This is not rare, especially when Esmarch bandage is used in the surgery. Rehabilitation of the knee joint can only begin after removing the plaster, resulting in slower recovery of the range of knee movement and also in slower and longer improvement of the patient’s gait. An external fixative to retain the achieved correction is also not well tolerated by patients. There is a high risk for pin site infection, which requires observance of strict hygiene rules to prevent it.

At the four year follow-up, 81.25% of the knee joints that underwent high tibial osteotomy were pain-free. The pain-free joints after the partial knee arthroplasty, by comparison, were 85.07%. 12.50% of patients reported pain at motion after HTO, while only 8.50% of the patients with prosthetic knees reported such pain. The pain was persistent in 6.29% of the joints after HTO, and in 6.20% of operated knees after UKA (Fig. 1).

The above results allow us to draw the conclusion that knee pain can be efficiently managed by both procedures, but after UKA complaint of pain in the knee joint is considerably less in comparison with HTO.

In terms of range of motion of the operated knee joints, minor differences between the two methods of treatment were found over the follow-up period. The resulting range of extension in all prosthetic joints is full, unlike the joints with HTO. In HTO, 89.58% of the joints had a complete range of extension and in 10.42% of these there was some deficiency.

At the 4 year follow-up, 92.05% of the HTO patients had a normal gate, while normal gate in the UKA patients was found in 95.38%. Limping was observed in 2.27% of osteotomy patients while those with knee prosthesis were 4.61%. Patients with unicompartmental knee arthroplasty could move without aids unlike 5.68% of those with high tibial osteotomy (Fig. 2).

UKA influences in a positive way the gait of patients. After improving the functional status of the knee, the gait also becomes normal. Patients regain their posture and gait and start to move normally. Only a small percentage of patients are left limping, which however does not affect their daily activity.17,18 Walking and movement of patients after UKA is done completely independently while part of HTO patients used aids to move and perform self-service. The final clinical assessment for the two techniques for treatment of unicompartmental gonarthrosis showed excellent result in 85.13% of knee joints following UKA versus 54.18% after HTO; good result in 13.11% after partial prosthesis versus 32.29% after HTO; satisfactory results in 1.77% after UKA versus 6.25% after tibial osteotomy. No poor result was recorded at the four-year follow-up after UKA, while after high tibial osteotomy poor results were seen in 7.28% of patients (Fig. 3).
Our results are in line with literature data (Berger et al 2005, Khumrak 2011) regarding the surgical treatment of unicompartmental osteoarthritis. Comparing these with the results after HTO, at the four-year follow-up, our results add support to the widely held view that unicondylar knee arthroplasty is a reasonable alternative of high tibial osteotomy in the treatment of isolated gonarthrosis.

We did not register cases of loosening and wear of the polyethylene tibial component or a combination of both for the period of clinical and radiographic follow-up. These complications are identified as the most common after partial knee prosthesis.9,10 During the study period, we did not register cases of deterioration of the opposite compartment and progression of osteoarthritis in the patellofemoral joint (Figs 4, 5, 6, 7). Based on the radiographs of patients preoperatively and during their follow-up there was evidence that high tibial osteotomy led to a temporary suspension of degenerative changes progression in the operated knee, but did not stop the arthritic process (Figs 8, 9, 10). In HTO patients degenerative changes of the patellofemoral joint develop faster. This is observed especially in patients who needed postoperative plaster immobilization. In HTO patients with no intervention on the patella, e.g ventralization, the patellofemoral joint arthrosis was progressing faster than tibiofemoral joint arthrosis after osteotomy.

![Figure 4](image1.png)  
**Figure 4.** A 57-year-old woman with osteoarthritis, grade 2 by Ahlbäck.

![Figure 5](image2.png)  
**Figure 5.** Six months after UKA.
Comparative Analysis of the Results Obtained after Unicondylar Knee Arthroplasty and High Tibial Osteotomy in Isolated Gonarthrosis

**Figure 6.** One year after UKA.

**Figure 7.** Three years after UKA.

**Figure 8.** A 64-year-old woman with osteoarthritis of right knee joint.
CONCLUSIONS
Clinical and radiographic results after UKA show better dynamics than that after high tibial osteotomy. UKA is a resurfacing procedure while HTO only slows the degenerative process of osteoarthritis with progressive deterioration in time. UKA allows early active rehabilitation which is beneficial for the rapid functional recovery of the knee joint. UKA is a minimally invasive procedure preserving the knee extensor mechanism, its proprioception, also preserving bone substance and resulting in less post-operative complications.

REFERENCES